ARCADIS Design & Consultancy for natural and built assets

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ENVIRONMENT

Subject:

2018 Third Quarter Operation Maintenance and Monitoring Report, Operable Unit 2, Northrop Grumman Systems Corporation and Naval Weapons Industrial Reserve Plant (NWIRP) Sites, Bethpage, New York. (NYSDEC Site #s 1-30-003A and B)

Date:
November 29, 2018

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Our ref:
NY001496.22TM.RPTI4
NY001496.23TM.NAVI4

Dear Jason:

On behalf of Northrop Grumman Systems Corporation (Northrop Grumman), Arcadis is providing the NYSDEC with the 2018 Third Quarter Operation Maintenance and Monitoring Report (Report). This Report was prepared to document the operation, maintenance, and monitoring (OM&M) activities conducted for the on-site portion of the Operable Unit 2 (OU2) groundwater remedy and the results of ongoing volatile organic compound (VOC) and inorganic monitoring in groundwater to meet the remedial objectives set forth in the March 2001 OU2 Record of Decision (ROD).

Table 1 summarizes OU2 remedial system performance operational data, total mass removal, and water balance. Tables 2 and 3 provide the analytical results for remedial system water and vapor samples for this period, respectively. Tables 4A and 4B provide the air modeling inputs and outputs and resulting analyses, based on quarterly vapor samples collected from the Tower 96 and Tower 102 systems, respectively, for this period. Tables 5A and 5B provide a summary of percent mass emittance of TCE from third quarter 2017 through third quarter 2018. Table 6 provides the validated analytical results of groundwater monitoring for this period. Figures 1 through 3 show the Locations of Wells and Onsite Groundwater Remedy, ONCT Groundwater Extraction and Treatment System Site Plan, and the ONCT Groundwater Extraction and Treatment System Schematic, respectively.

Please contact us if you have any questions or comments.

Sincerely,

Arcadis of New York, Inc.

Christopher Engler, P.E. 069748
Engineer of Record

Copies:

Ed Hannon, Northrop Grumman
Walter Parish, NYSDEC
Donald Hesler, NYSDEC
Steven Scharf, NYSDEC
Steven Karpinski, NYS Department of Health
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TABLES

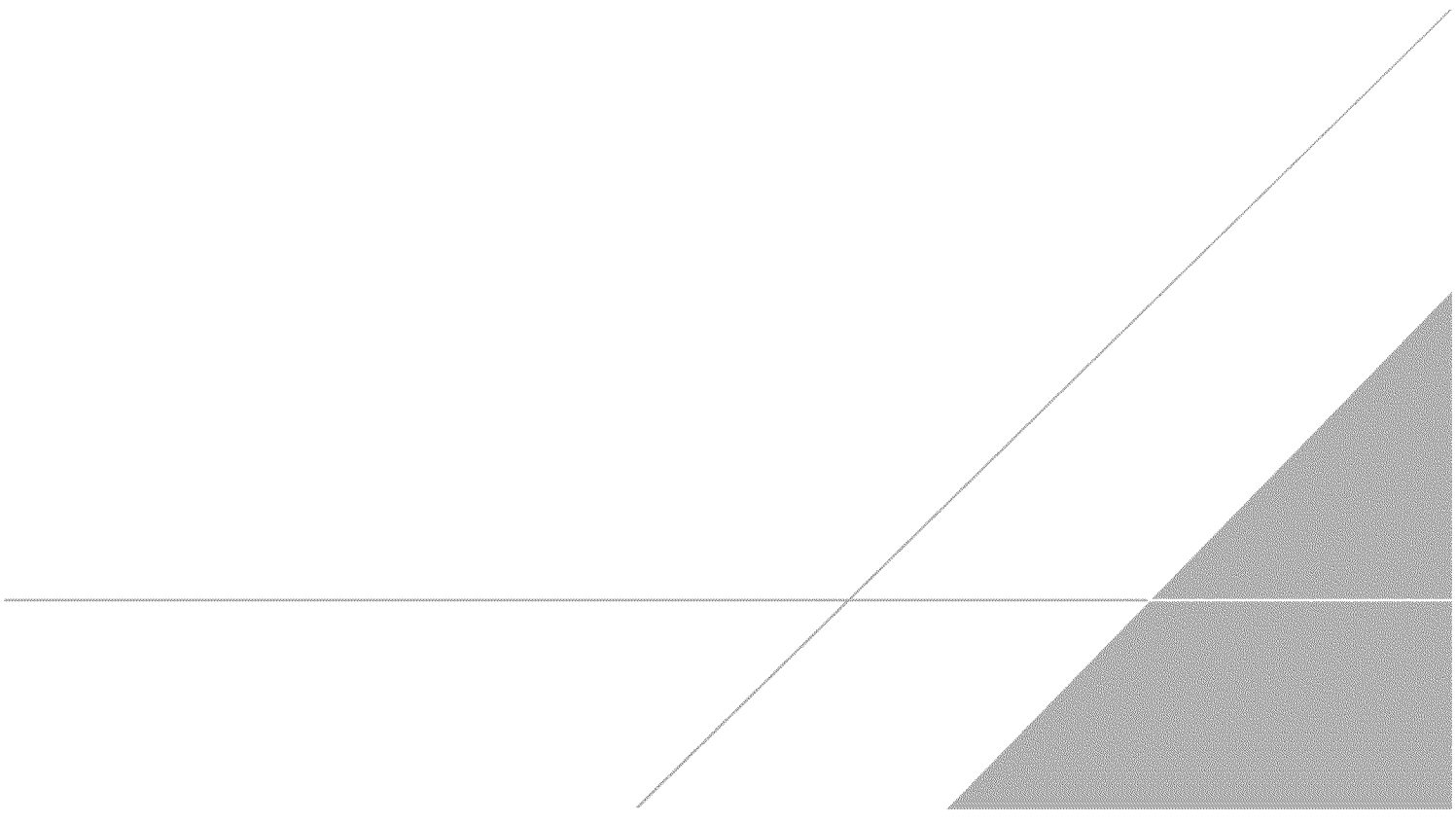

Table 1
Operational Summary for the On-Site Portion of the OU2 Groundwater Remedy, Third Quarter 2018[1] Reporting Period
Operable Unit 2, Northrop Grumman Systems Corporation,
Bethpage, New York

	Quarterly Flow Rates (gpm)		Quarterly Flow Volumes (MG)			Quarterly VOC Concentrations (µg/L)		VOC Mass Removed (lbs) [7]		
	Design [2]	Average [3,4]	Design [2]	Actual [3,4]	% of Design	TCE [5]	TVOC [5,6]	Quarterly	Annual	Cumulative
Influent Groundwater										
Well 1 [11]	800	704	102.5	65.4	64%	554	590	322	1,394	47,373
Well 3R [11]	700	639	89.7	58.6	65%	272	310	152	704	91,293
Well 17 [11,12]	1,000	1,014	128.2	126.4	99%	96	120	127	420	53,447
Well 18 [11,12]	600	816	76.9	101.7	132%	39	59	50	170	6,539
Well 19 [11,12]	700	516	89.7	64.3	72%	108	130	70	220	8,600
Total [13]	**3,800**	**3,689**	**487**	**416**	**85%**	**--**	**--**	**721**	**2,908**	**207,252**
Effluent Groundwater [8]										
Calpine	100 - 400	222	--	28.5	--	--	--	--	--	--
OXY Biosparge [10]	2 - 42	0	--	0	--	--	--	--	--	--
West Recharge Basins	1,112 - 1,455	2,022	--	259.1	--	--	0.7	--	--	--
South Recharge Basins [12]	2,231	1,002	285.9	128.4	45%	--	1.3	--	--	--
Total [14]	**--**	**3,246**	**--**	**416**	**--**					
Additional Flow to South Recharge Basins										
Storm Water Runoff Contributing to South Recharge Basins Flow Volume [14]	--	--	--	37.3	--	--	--	--	--	--
Total Flow Volume to South Recharge Basins [12,14,15]			**286**	**166**	**58%**					

Treatment Efficiencies [9]	
Tower 96 System:	>99.9%
Tower 102 System:	>99.9%

Notes and abbreviations on last page.

Table 1
Operational Summary for the On-Site Portion of the OU2 Groundwater Remedy, Third Quarter 2018[(1)] Reporting Period
Operable Unit 2, Northrop Grumman Systems Corporation,
Bethpage, New York

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Notes and Abbreviations:

(1) Quarterly reporting period: July 03, 2018 through September 30, 2018
(2) "Design" flow rates were determined for the five remedial wells and for the South Recharge Basins based on computer modeling (ARCADIS G&M, Inc. 2003c, modified in April 2005). Flow rates for Calpine, OXY Biosparge and West Recharge Basins are typical flow rates and are provided for reader information. "Design" flow volumes represent the volume of water that should be pumped/discharged during the reporting period and is calculated by multiplying the design rate by the reporti ng period duration.
(3) "Average" flow rates for the remedial wells represent the average actual pumping rates when the pumps are operational and d o not take into account the time that a well is not operational. During this quarterly reporting period, the remedial wells operated for the following percentage of the time: Well 1 (72.4%), Well 3R (71.5%), Well 17 (97.2%), Well 18 (97.3%), and Well 19 (97.2%). "Actual" volumes are determined via totalized values computed by SCADA using the instantaneous flow rate s transmitted from local flow meters.
(4) "Average" flow rates for the system discharges represent the average flow rate during the entire reporting period and are determined by dividing the total flow during the reporting period b y the reporting period duration. The Calpine and South Recharge Basins flow volumes are determined via totalized values computed by SCADA using the instantaneous flow rates transmitted from local flow meters. The West Recharge Ba sin flow is calculated by subtracting the cumulative flow to the other discharges from the total influent flow. Actual flow t o the recharge basins is greater, as shown, because storm water combines with the plant effluent prior to discharge to the recharge basins.
(5) The TCE and TVOC concentrations for the remedial wells are from the quarterly sampling event performed during this reporting p eriod on September 5, 2018.
(6) The TVOC concentration for the two sets of recharge basins are their respective average monthly SPDES concentration for the current quarter.
(7) TVOC mass removed for the reporting period is calculated by mul tiplying the TVOC concentration from the quarterly sampling event and the quantity of water pumped during the reporting period .
(8) There are four discharges for the effluent groundwater: South Recharge Basins, West Recharge Basins, Calpine and OXY Biosparge system. Treated water is continuously dischar ged to the south and west recharge basins, and is available "on-demand" to both the Calpine Power Plant (Calpine) for use as make-up water, and the biosparge remediation system oper ated by Occidental Chemical (OXY Biosparge).
(9) Treatment System Efficiencies are calculated by dividing the di fference between the remedial well flow weighted influent and e ffluent TVOC concentrations by the remedial well flow weighted influent concentration.
(10) Occidental Chemical has not reported any water usage for the O XY Biosparge system since May 2016.
(11) The downtime during Third Quarter 2018 was minor and due to typ ical operation and maintenance with the exception of Tower 96 . Tower 96 shut down from July 12, 2018 through August 1, 2018 d ue to failure and repair of supplem ental blower shaft bearings. See Note 12 for detail on reduced percent design flow values.
(12) During the third quarter, the pumping rates for Wells 1 and 3R were reduced from August 1, 2018 to August 30, 2018 due to supp lemental bower repairs at Tower 96. The pumping rates for Wells 18 and 19 continued to be adjusted to maximize capture efficie ncy. Additionally, flow was diverted to the West Basins to accommodate basin rehabilitation work at the center most of the South Basins. Average pumping rates and modified South Basin recharge rates are shown above.
(13) Total pumpage/recharge rates are accurate to ±15% due to limitations in metering.
(14) Storm Water Runoff Volume is calculated by multiplying the adju sted tributary area and NOAA precipitation data for the reporti ng periods. The adjusted tributary area is tributary area that is adjusted by the runoff coefficient to exclude the infiltrati on volume from the total rainfall volume. The tributary area, runoff coefficient, and adjusted tributary area are from Dvirka and Bartilucci Consulting Engineers' Storm Water Permit Evaluation Report (January, 28, 2010). The NOAA precipitation d ata are calculated as a sum of NOAA daily precipitation data for the reporting period. NOAA precipitation data are retrieved from Station GHCND:USW00054787 - FARMINGDALE REPU BLIC AIRPORT, NY US.
(15) Total Flow Volume to South Recharge Basins is estimated as a sum of flow vol umes contributed from the Effluent Groundwater to South Recharge Basins and from Storm Water Runoff to South Rech arge Basins.

--	Not Applicable	NOAA	National Oceanic and Atmospheric Administra tion
µg/L	micrograms per liter	SCADA	Supervisory Controls and Data Acqu isition
gpm	gallons per minute	SPDES	State Pollution Discharge Elimination System
lbs	pounds	TCE	trichloroethene
MG	million gallons	TVOC	total volatile organic compounds
		VOC	volatile organic compounds

Table 2
Concentrations of Constituents in Remedial Wells and
Treatment System Effluents, Third Quarter 2018, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

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Constituents[1] (units in µg/L)	Location ID: Sample ID: Sample Date:	WELL 1 WELL 1 9/5/2018	WELL 3R WELL 3R 9/5/2018	96 EFFLUENT 96 EFFLUENT 9/5/2018	WELL 17 WELL 17 9/5/2018
Volatile Organic Compounds (VOCs)[2]					
1,1,1-Trichloroethane		<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane		<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane		<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane		**0.71 J**	**1.3**	<1.0	**0.74 J**
1,1-Dichloroethene		**2.6**	**3.5**	<0.50	**1.4**
1,2-Dichloroethane		<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane		**4.3**	<1.0	<1.0	<1.0
2-Butanone (MEK)		<10	<10	<10	<10
2-Hexanone (MBK)		<5.0	<5.0	<5.0	<5.0
4-methyl-2-pentanone (MIK)		<5.0	<5.0	<5.0	<5.0
Acetone		<10	<10	<10	<10
Benzene		<0.50	<0.50	<0.50	<0.50
Bromodichloromethane		<1.0	<1.0	<1.0	<1.0
Bromoform		<1.0	<1.0	<1.0	<1.0
Bromomethane		<2.0	<2.0	<2.0	<2.0
Carbon Disulfide		<2.0	<2.0	<2.0	<2.0
Carbon Tetrachloride		<1.0	<1.0	<1.0	<1.0
Chlorobenzene		<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0	<1.0	<1.0
Chloroform		<0.50	<0.50	<0.50	<0.50
Chloromethane		<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		**5.6**	**3.7**	<0.50	**2.4**
cis-1,3-Dichloropropene		<1.0	<1.0	<1.0	<1.0
Dibromochloromethane		<1.0	<1.0	<1.0	<1.0
Ethylbenzene		<1.0	<1.0	<1.0	<1.0
Methylene Chloride		<0.50	<0.50	<0.50	<0.50
Styrene		<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		**19.4**	**26.4**	<0.50	**18.1**
Toluene		<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene		<0.50	<0.50	<0.50	<0.50
trans-1,3-Dichloropropene		<1.0	<1.0	<1.0	<1.0
Trichloroethylene		**554**	**272**	<0.50	**96.4**
Trichlorotrifluoroethane (Freon 113)		**3.8**	**2.8**	<0.50	**2.5**
Vinyl Chloride		<0.50	**1.9**	<0.50	<0.50
Xylene-o		<1.0	<1.0	<1.0	<1.0
Xylene-m,p		<1.0	<1.0	<1.0	<1.0
Total VOCs[3]		**590**	**310**	0	**120**
1,4-Dioxane[2]		**6.4**	**11**	**9.0**	**4.8**

Notes and abbreviations on last page.

Table 2
Concentrations of Constituents in Remedial Wells and
Treatment System Effluents, Third Quarter 2018, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

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Constituents[1] (units in µg/L)	Location ID: Sample ID: Sample Date:	WELL 17 REP-090518-JJC-1 9/5/2018	WELL 18 WELL 18 9/5/2018	WELL 19 WELL 19 9/5/2018	102 EFFLUENT 102 EFFLUENT 9/5/2018
Volatile Organic Compounds (VOCs)[2]					
1,1,1-Trichloroethane		<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane		<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane		<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane		**0.76 J**	**1.2**	**0.59 J**	<1.0
1,1-Dichloroethene		**1.5**	**2.8**	**1.2**	<0.50
1,2-Dichloroethane		<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane		<1.0	<1.0	<1.0	<1.0
2-Butanone (MEK)		<10	<10	<10	<10
2-Hexanone (MBK)		<5.0	<5.0	<5.0	<5.0
4-methyl-2-pentanone (MIK)		<5.0	<5.0	<5.0	<5.0
Acetone		<10	<10	<10	<10
Benzene		<0.50	<0.50	<0.50	<0.50
Bromodichloromethane		<1.0	<1.0	<1.0	<1.0
Bromoform		<1.0	<1.0	<1.0	<1.0
Bromomethane		<2.0	<2.0	<2.0	<2.0
Carbon Disulfide		<2.0	<2.0	<2.0	<2.0
Carbon Tetrachloride		<1.0	<1.0	<1.0	<1.0
Chlorobenzene		<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0	<1.0	<1.0
Chloroform		<0.50	<0.50	<0.50	<0.50
Chloromethane		<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		**2.6**	**2.6**	**14.7**	<0.50
cis-1,3-Dichloropropene		<1.0	<1.0	<1.0	<1.0
Dibromochloromethane		<1.0	<1.0	<1.0	<1.0
Ethylbenzene		<1.0	<1.0	<1.0	<1.0
Methylene Chloride		<0.50	<0.50	<0.50	<0.50
Styrene		<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		**18.7**	**13.5**	**6.2**	<0.50
Toluene		<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene		<0.50	<0.50	<0.50	<0.50
trans-1,3-Dichloropropene		<1.0	<1.0	<1.0	<1.0
Trichloroethylene		**98.4**	**38.5**	**108**	<0.50
Trichlorotrifluoroethane (Freon 113)		**2.6**	<0.50	<0.50	<0.50
Vinyl Chloride		<0.50	<0.50	<0.50	<0.50
Xylene-o		<1.0	<1.0	<1.0	<1.0
Xylene-m,p		<1.0	<1.0	<1.0	<1.0
Total VOCs[3]		**120**	**59**	**130**	0
1,4-Dioxane[2]		**5.1**	**4.9**	**4.4**	**5.5**

Notes and abbreviations on last page.

Table 2
Concentrations of Constituents in Remedial Wells and
Treatment System Effluents, Third Quarter 2018, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

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Notes and Abbreviations:

(1) Results for the program are validated at 20% frequency, per protocols specified in OU2 Groundwater Monitoring Plan (Arcadis 2016c).

(2) VOC samples analyzed using USEPA Method 8260C. 1,4-dioxane samples analyzed using USEPA Method 8270D-SIM.

(3) Total VOC results rounded to two significant figures.

2.6 Bold value indicates a detection.
< 5.0 Compound is not detected above its laboratory quantification limit.
J Constituent value is estimated.
µg/L micrograms per liter
OU2 Operable Unit 2
REP Blind Replicate Sample
USEPA United States Environmental Protection Agency
VOC Volatile Organic Compound

Table 3
Vapor Sample Analytical Results for Treatment Systems,
Third Quarter 2018,
Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Location ID: / Sample ID: / Constituents (Units in µg/m^3)	96 INFLUENT T96 INFLUENT (AA) 9/5/2018	96 MID-EFFLUENT T96 MIDTRAIN (AA) 9/5/2018	96 EFFLUENT T96 EFFLUENT (AA) 9/5/2018
Volatile Organic Compounds (VOCs)[1]			
1,1,1-Trichloroethane	**17**	**3.9**	**0.76**
1,1,2,2-Tetrachloroethane	<0.55	<0.55	<0.55
1,1,2-Trichloroethane	**2.7**	<0.44	<0.44
1,1-Dichloroethane	**41.7**	**32**	**36**
1,1-Dichloroethene	**118**	**110**	**75.3**
1,2-Dichloroethane	**2.2**	**0.65**	**0.36 J**
1,2-Dichloropropane	**98.4**	**13**	**1.6**
Benzene	**1.2**	**0.27 J**	**0.93**
Bromodichloromethane	<0.54	<0.54	<0.54
Bromoform	<0.33	<0.33	<0.33
Bromomethane	<0.62	<0.62	<0.62
Carbon Disulfide	<0.50	<0.50	**0.53**
Carbon Tetrachloride	**3.4**	**0.18 J**	<0.20
Chlorobenzene	**1.5**	<0.74	<0.74
Chloroethane	**3.4**	**3.7**	**2.6**
Chloroform	**15**	**7.8**	**7.3**
Chloromethane	**0.70**	**0.87**	**4.1**
cis-1,2-Dichloroethene	**201**	**148**	**132**
cis-1,3-Dichloropropene	<0.73	<0.73	<0.73
Dibromochloromethane	<0.68	<0.68	<0.68
Ethylbenzene	<0.69	<0.69	<0.69
Methylene Chloride	**0.73**	**0.76**	**0.69**
Styrene	<0.68	<0.68	<0.68
Tetrachloroethene	**848**	**44**	**1.6**
Toluene	**0.53 J**	<0.60	**75.4**
trans-1,2-Dichloroethene	**2.3**	**1.8**	**2.2**
trans-1,3-Dichloropropene	<0.73	<0.73	<0.73
Trichloroethylene	**18,700**	**3,650**	**693**
Trichlorotrifluoroethane (Freon 113)	**123**	**54**	**21**
Vinyl Chloride	**32.5**	**35.3**	**27.1**
Xylene-o	<0.69	<0.69	<0.69
Xylene-m,p	<0.69	<0.69	<0.69
Total VOCs [2]	**20,213**	**4,106**	**1,082**

Notes and abbreviations on last page.

Table 3
Vapor Sample Analytical Results for Treatment Systems,
Third Quarter 2018,
Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York

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Location ID: / Sample ID: / Constituents (Units in µg/m^3)	102 INFLUENT T102 INFLUENT (AA) 9/5/2018	102 EFFLUENT T102 EFFLUENT (AA) 9/5/2018
Volatile Organic Compounds (VOCs)[1]		
1,1,1-Trichloroethane	**16**	<0.55
1,1,2,2-Tetrachloroethane	<0.55	<0.69
1,1,2-Trichloroethane	**1.4**	<0.55
1,1-Dichloroethane	**63.5**	**2.1**
1,1-Dichloroethene	**124**	**12**
1,2-Dichloroethane	**3.6**	<0.81
1,2-Dichloropropane	**7.9**	<0.92
Benzene	**0.73**	<0.64
Bromodichloromethane	<0.54	<0.67
Bromoform	<0.33	<0.41
Bromomethane	<0.62	<0.78
Carbon Disulfide	<0.50	<0.62
Carbon Tetrachloride	**4.3**	<0.25
Chlorobenzene	<0.74	<0.92
Chloroethane	<0.42	<0.53
Chloroform	**17**	<0.98
Chloromethane	**0.89**	**0.85**
cis-1,2-Dichloroethene	**500**	**5.6**
cis-1,3-Dichloropropene	<0.73	<0.91
Dibromochloromethane	<0.68	<0.85
Ethylbenzene	<0.69	<0.87
Methylene Chloride	**0.56**	**1.7**
Styrene	<0.68	<0.85
Tetrachloroethene	**351**	<0.27
Toluene	**0.87**	<0.75
trans-1,2-Dichloroethene	**5.2**	<0.79
trans-1,3-Dichloropropene	<0.73	<0.91
Trichloroethylene	**3,480**	**1.1**
Trichlorotrifluoroethane (Freon 113)	**110**	**2.7**
Vinyl Chloride	**0.25**	**0.28**
Xylene-o	<0.69	<0.87
Xylene-m,p	<0.69	<0.87
Total VOCs [2]	**4,687**	**26**

Notes and abbreviations on last page.

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Notes and Abbreviations:

(1)	Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.
(2)	Total VOCs represents the sum of individual concentrations of compounds detected rounded to the nearest whole number.
3.9	bold value indicates a detection
J	Compound detected below its reporting limit; value is estimated.
µg/m^3	micrograms per cubic meter
ELAP	Environmental Laboratory Approval Program
NYSDOH	New York State Department of Health
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Table 4A
Summary of AERMOD Air Quality Impact Analysis
Tower 96 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

Constituent	CAS#	T96 Effluent (ug/m^3)	Emission Rate[1]			Scaled Impact - Hourly [2] (ug/m^3)	Scaled Impact - Annual [2] (ug/m^3)	SGC (3) (ug/m^3)	AGC(3) (ug/m^3)	%SGC	% AGC
		9/5/2018	lb/yr	lb/hr	g/s						
1,1,1 - Trichloroethane	00071-55-6	**0.76**	0.12	1.37E-05	1.72E-06	2.55E-04	7.48E-06	9,000	5,000	0.00%	0.00%
1,1 - Dichloroethane	00075-34-3	**36**	5.67	6.48E-04	8.16E-05	1.21E-02	3.55E-04	--	6.30E-01	--	0.06%
1,2 - Dichloroethane	00107-06-2	**0.36**	0.06	6.48E-06	8.16E-07	1.21E-04	3.55E-06	--	3.80E-02	--	0.01%
1,1 - Dichloroethene	00075-35-4	**75.3**	11.87	1.35E-03	1.71E-04	2.53E-02	7.42E-04	--	200	--	0.00%
Tetrachloroethene	00127-18-4	**1.6**	0.25	2.88E-05	3.63E-06	5.37E-04	1.58E-05	300	4	0.00%	0.00%
Trichloroethene[4]	00079-01-6	**693**	109.21	1.25E-02	1.57E-03	2.33E-01	6.83E-03	20	2.00E-01	1.16%	3.41%
Vinyl Chloride[4]	00075-01-4	**27.1**	4.27	4.88E-04	6.14E-05	9.09E-03	2.67E-04	180,000	1.10E-01	0.00%	0.24%
cis 1,2-Dichloroethene	00156-59-2	**132**	20.80	2.37E-03	2.99E-04	4.43E-02	1.30E-03	--	63	--	0.00%
trans 1,2-Dichloroethene	00156-60-5	**2.2**	0.35	3.96E-05	4.99E-06	7.38E-04	2.17E-05	--	63	--	0.00%
Benzene[4]	00071-43-2	**0.93**	0.15	1.67E-05	2.11E-06	3.12E-04	9.16E-06	1,300	1.30E-01	0.00%	0.01%
Toluene	00108-88-3	**75.4**	11.88	1.36E-03	1.71E-04	2.53E-02	7.43E-04	37,000	5,000	0.00%	0.00%
1,2-Dichloropropane	00078-87-5	**1.6**	0.25	2.88E-05	3.63E-06	5.37E-04	1.58E-05	--	4	--	0.00%
Carbon Disulfide	00075-15-0	**0.53**	0.08	9.53E-06	1.20E-06	1.78E-04	5.22E-06	6200	700	0.00%	0.00%
Chloroethane	00075-00-3	**2.6**	0.41	4.68E-05	5.89E-06	8.73E-04	2.56E-05	--	10,000	--	0.00%
Chloroform	00067-66-3	**7.3**	1.15	1.31E-04	1.65E-05	2.45E-03	7.19E-05	150	15	0.00%	0.00%
Chloromethane	00074-87-3	**4.1**	0.65	7.38E-05	9.29E-06	1.38E-03	4.04E-05	22,000	90	0.00%	0.00%
Dichloromethane	00075-09-2	**0.69**	0.11	1.24E-05	1.56E-06	2.32E-04	6.80E-06	14,000	60	0.00%	0.00%
Trichlorotrifluoroethane (Freon 113)	00076-13-1	**21**	3.31	3.78E-04	4.76E-05	7.05E-03	2.07E-04	960,000	180,000	0.00%	0.00%

Notes and Abbreviations on next page

Table 4A
Summary of AERMOD Air Quality Impact Analysis
Tower 96 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

Notes and Abbreviations:

(1) Emission rate calculated based on effluent concentration and a stack air flow rate of 4,770 cfm. The stack air flow rate (in acfm) is taken from the actual stack air flow rate on 9/05/2018. Effluent temperature used in the model was 92 °F from direct read in-line gauge.
Trichloroethene (lb/hr) = (10 ug/m^3) x (4,770 ft^3/min) x (1 m^3/35 ft^3) x (60 min/hr) x (0.000001 g/1 ug) x (0.0022 lb/g)
lb/yr = lb/hr x 8,760 hrs/yr
g/s = lb/hr x 1 hr/3,600 sec x 453.59 g/1 lb

(2) Ambient impact based on AERMOD modeling using normalized rate of 1 g/s is scaled to the actual emission rate of the pollutant. Modeling was performed using the representative meteorological data from the nearest station (Farmingdale, NY) for the years 2011 through 2015, and a stack which is 55 feet high and 20 inches in diameter. The maximum impact from all the years was used for the calculations.
Scaled hourly impact (ug/m^3) = AERMOD predicted hourly ambient impact at 1 g/s ([ug/m^3]/[g/s]) x Actual emission rate (g/s)
Scaled annual impact (ug/m^3) = AERMOD predicted annual ambient impact at 1 g/s ([ug/m^3]/[g/s]) x Actual emission rate (g/s)

AERMOD Normalized Ambient Impact at 1 g/s	
Hourly ([ug/m^3]/[g/s])	Annual ([ug/m^3]/[g/s])
148.05	4.35

(3) Short-term and annual guideline concentrations for air toxic pollutants specified in the NYSDEC DAR-1 AGC/SGC tables revised August 10, 2016.

(4) Vinyl Chloride and Benzene potential emission rates are less than 0.1 lb/hr and therefore below the trigger emissions for degree of air cleaning requirement (6 CRR-NY 212-2.3). TCE potential emissions are above the trigger limit and require a 12 month rolling average of annual emission to be maintained (see Table 5A) to demonstrate compliance with the 6 CRR-NY 212-2.2 500 lb/year requirement.

AGC	Annual Guideline Concentration	**36**	bold value indicates a detection
CAS #	Chemical Abstracts Service Registry Number	acfm	actual cubic feet per minute
CRR-NY	New York Codes, Rules and Regulations	g/s	grams per second
DAR-1	Division of Air Resources-1	µg/m^3	micrograms per cubic meter
--	None Specified	lb/yr	pounds per year
NYSDEC	New York State Department of Environmental Conservation	lb/hr	pounds per hour
SGC	Short-term Guideline Concentration		

Table 4B
Summary of AERMOD Air Quality Impact Analysis
Tower 102 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

Constituent	CAS#	T102 Effluent (ug/m^3)	Emission Rate[1]			Scaled Impact - Hourly[2] (ug/m^3)	Scaled Impact - Annual[2] (ug/m^3)	SGC[3] (ug/m^3)	AGC[3] (ug/m^3)	%SGC	% AGC
		9/5/2018	lb/yr	lb/hr	g/s						
1,1 - Dichloroethane	00075-34-3	**2.1**	0.57	6.55E-05	8.25E-06	2.88E-03	1.88E-05	--	6.30E-01	--	0.00%
1,1 - Dichloroethene	00075-35-4	**12**	3.28	3.74E-04	4.71E-05	1.64E-02	1.08E-04	--	200	--	0.00%
Trichloroethene[4]	00079-01-6	**1.1**	0.30	3.43E-05	4.32E-06	1.51E-03	9.87E-06	20	2.00E-01	0.01%	0.00%
Vinyl Chloride[4]	00075-01-4	**0.28**	0.07	8.16E-06	1.03E-06	3.59E-04	2.35E-06	180,000	1.10E-01	0.00%	0.00%
cis 1,2-Dichloroethene	00156-59-2	**5.6**	1.53	1.75E-04	2.20E-05	7.67E-03	5.02E-05	--	63	--	0.00%
Chloromethane	00074-87-3	**0.85**	0.23	2.65E-05	3.34E-06	1.16E-03	7.63E-06	22,000	90	0.00%	0.00%
Dichloromethane	00075-09-2	**1.7**	0.46	5.30E-05	6.68E-06	2.33E-03	1.53E-05	14,000	60	0.00%	0.00%
Trichlorotrifluoroethane (Freon 113)	00076-13-1	**2.7**	0.69	7.87E-05	9.92E-06	3.46E-03	2.27E-05	960,000	180000	0.00%	0.00%

Notes and Abbreviations:

(1) Emission rate calculated based on effluent concentration and a stack air flow rate of 7,640 cfm. The stack air flow rate (in acfm) is taken from the actual stack air flow rate on 9/05/2018. Effluent temperature used in the model was 80°F from direct read in-line gauge.
Trichloroethene (lb/hr) = (1.6 ug/m^3) x (7,640 ft^3/min) x (1 m^3/35 ft^3) x (60 min/hr) x (0.000001 g/1 ug) x (0.0022 lb/g)
lb/yr = lb/hr x 8,760 hrs/yr
g/s = lb/hr x 1 hr/3,600 sec x 453.59 g/1 lb

(2) Ambient impact based on AERMOD modeling using noramalized rate of 1 g/s is scaled to the actual emission rate of the pollutant. Modeling was performed using the representative meteorological data from the nearest station (Farmingdale, NY) for the years 2011 through 2015, and a stack which is 69.52 feet high and 24 inches in diameter. The maximum impact from all the years was used for the calculations.
Scaled hourly impact (ug/m^3) = AERMOD predicted hourly ambient impact at 1 g/s ([ug/m^3]/[g/s]) x Actual emission rate (g/s)
Scaled annual impact (ug/m^3) = AERMOD predicted annual ambient impact at 1 g/s ([ug/m^3]/[g/s]) x Actual emission rate (g/s)

AERMOD Normalized Ambient Impact at 1 g/s	
Hourly ([ug/m^3]/[g/s])	Annual ([ug/m^3]/[g/s])
348.85	2.29

(3) Short-term and annual guideline concentrations for air toxic pollutants specified in the NYSDEC DAR-1 AGC/SGC tables revised August 10, 2016.
(4) Vinyl Chloride potential emission rate is less than 0.1 lb/hr and therefore below the trigger emissions for degree of air cleaning requirement (6 CRR-NY 212-2.3). TCE potential emissions are above the trigger limit and require a 12 month rolling average of annual emission to be maintained (see Table 5B) to demonstrate compliance with the 6 CRR-NY 212-2.2 500 lb/year requirement.

AGC	Annual Guideline Concentration
CAS #	Chemical Abstracts Service Registry Number
CRR-NY	New York Codes, Rules and Regulations
DAR-1	Division of Air Resources-1
--	None Specified
NYSDEC	New York State Department of Environmental Conservation
SGC	Short-term Guideline Concentration

2.1	bold value indicates a detection
acfm	actual cubic feet per minute
g/s	grams per second
µg/m^3	micrograms per cubic meter
lb/yr	pounds per year
lb/hr	pounds per hour

Table 5A
Summary of TCE Mass Removal, Tower 96 Treatment System,
Third Quarter 2018, Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York[1,2,3]

Date	TCE Concentration (µg/m^3)				TCE Mass Emission[3]	Percent of Allowable TCE Emissions[4]
	T96 INFLUENT	T96 MIDTRAIN	T96 SUP MIDTRAIN	T96 EFFLUENT	(lbs)	12 Month Rolling Average
7/18/2017	NS	NS	NS	3,360	30	63.4%
8/18/2017 [5]	NS	NS	NS	4,745	66	76.7%
9/19/2017	12,100	6,610	3,670	6,130	87	92.4%
12/13/2017	18,600	6,610	95	10	0.1	91.4%
1/31/2018	NS	3,510	2,710	17	0.4	91.3%
2/28/2018	13,000	2,860	3,930	86.5	1.0	91.4%
4/13/2018 [6]	13,000	NS	NS	232	4.4	52.9%
5/15/2018	17,400	5,430	14	1590	22	44.5%
9/5/2018 [7]	18,700	3,650	NS	693	34	20.0%

Notes and Abbreviations:

(1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.

(2) A carbon change out was performed in Supplemental Bed 1 and new carbon was placed in the previously empty Supplemental Bed 2 on May 18, 2017.

(3) TCE Mass Emission calculated based on the exhaust air flow rate on the day of sampling and the period of time since the preceding day of sampling.
TCE (lb) = TCE Concentration [µg/m^3] x Days x Flow Rate [ft^3/min] x (1 m^3/35 ft^3) x (60 min/hr) x (24 hr/day) x (0.000001 g/1 ug) x (0.0022 lb/g)

(4) Percent of allowable TCE emissions to date is a time-weighted annual rolling average based on the 500 lb/year emission limit specified in the CRR-NY 212-2.2 Table 2. High Toxicity Air Contaminant List, revised April 1, 2017.

(5) Sampling not conducted in August, the average of July and September effluent data and actual average air flow rate for the time period were used for estimated for August 18, 2017. calculations for August 18, 2017.

(6) Carbon changeout for Tower 96 lead supplemental bed was completed on April 6, 2018.

(7) Regenerative Carbon changeout for Tower 96 was completed on July 28, 2018.

µg/m^3	micrograms per cubic meter
lbs	pounds
CRR-NY	Codes, Rules and Regulations of the State of New York
ELAP	Environmental Laboratory Approval Program
NS	Not Sampled
NYSDOH	New York State Department of Health
SUP	Supplemental
TCE	Trichloroethylene
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Table 5B
Summary of TCE Mass Removal, Tower 102 Treatment System,
Third Quarter 2018,
Northrop Grumman Systems Corporation, Operable Unit 2,
Bethpage, New York[1,2,3]

ARCADIS Design & Consultancy for natural and built assets

Date	TCE Concentration (µg/m^3)		TCE Mass Emission[2]		Percentage of Allowable TCE Emissions[3]		T102 Treatment Efficiency
	T102 INFLUENT	T102 EFFLUENT	lbs	lbs/day	Period	12 Month Rolling Average	
6/30/2017	5,480	15	1.5	0.01	0.8%	0.9%	99.7%
10/17/2017	3,990	40	3.0	0.03	2.0%	1.3%	99.0%
12/21/2017	2,340	5	0.2	0.00	0.3%	1.1%	99.8%
2/28/2018	2,970	4	0.2	0.00	0.2%	0.9%	99.9%
5/10/2018	1,710	2	0.1	0.00	0.1%	1.2%	99.9%
9/5/2018	647	2	0.2	0.00	0.1%	0.4%	99.7%

Notes and Abbreviations:

(1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.

(2) TCE Mass Emission calculated based on the exhaust air flow rate on the day of sampling and the period of time since the preceding sampling day.

TCE (lb) = TCE Concentration [µg/m^3] x Days x Flow Rate [ft^3/min] x (1 m^3/35 ft^3) x (60 min/hr) x (24 hr/day) x (0.000001 g/1 ug) x (0.0022 lb/g)

(3) Percent of allowable TCE emissions to date is a time-weighted annual rolling average based on the 500 lb/year emission limit specified in the CRR-NY 212-2.2 Table 2. High Toxicity Air Contaminant List, revised April 1, 2017.

µg/m^3	micrograms per cubic meter
lbs	pounds
ELAP	Environmental Laboratory Approval Program
NYSDOH	New York State Department of Health
T102	Tower 102
TCE	trichloroethene
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

Table 6
Concentrations of Volatile Organic Compounds
and 1,4-Dioxane in Monitoring Wells [1]
BPOW 2-1, BPOW 2-2 and BPOW 2-3, Third Quarter 2018
Operable Unit 2 (Groundwater),
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

CONSTITUENT Units (ug/L)	Location ID: Sample ID: Date:	BPOW 2-1 BPOW 2-1 8/29/2018	BPOW 2-2 BPOW 2-2 9/6/2018	BPOW 2-3 BPOW 2-3 9/6/2018
Volatile Organic Compounds (VOCs) [2,3]				
1,1,1-Trichloroethane		< 0.50	< 0.50	< 0.50
1,1,2,2-Tetrachloroethane		< 0.50	< 0.50	< 0.50
1,1,2-trichloro-1,2,2-trifluroethane		< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane		< 0.50	< 0.50	< 0.50
1,1-Dichloroethane		< 0.50	< 0.50	< 0.50
1,1-Dichloroethene		< 0.50	< 0.50	< 0.50
1,2-Dichloroethane		< 0.50	< 0.50	< 0.50
1,2-Dichloropropane		< 0.50	< 0.50	< 0.50
2-Butanone (MEK)		< 5.0	< 5.0	< 5.0
2-Hexanone		< 2.0	< 2.0	< 2.0
4-methyl-2-pentanone (MIK)		< 2.0	< 2.0	< 2.0
Acetone		< 5.0	< 5.0	< 5.0
Benzene		< 0.50	< 0.50	< 0.50
Bromodichloromethane		< 0.50	< 0.50	< 0.50
Bromoform		< 0.50	< 0.50	< 0.50
Bromomethane		< 0.50	< 0.50	< 0.50
Carbon Disulfide		< 0.50	< 0.50	< 0.50
Carbon tetrachloride		< 0.50	< 0.50	< 0.50
Chlorobenzene		< 0.50	< 0.50	< 0.50
Chloroethane		< 0.50	< 0.50	< 0.50
Chloroform		< 0.50	< 0.50	< 0.50
Chloromethane		< 0.50	< 0.50	< 0.50
cis-1,2-dichloroethene		< 0.50	< 0.50	< 0.50
cis-1,3-dichloropropene		< 0.50	< 0.50	< 0.50
Dibromochloromethane		< 0.50	< 0.50	< 0.50
Ethylbenzene		< 0.50	< 0.50	< 0.50
Methylene Chloride		< 0.50	< 0.50	< 0.50
Styrene		< 0.50	< 0.50	< 0.50
Tetrachloroethene		< 0.50	< 0.50	< 0.50
Toluene		< 0.50	< 0.50	< 0.50
trans-1,2-dichloroethene		< 0.50	< 0.50	< 0.50
trans-1,3-dichloropropene		< 0.50	< 0.50	< 0.50
Trichloroethylene		< 0.50	< 0.50	< 0.50
Vinyl Chloride		< 0.50	< 0.50	< 0.50
Xylene-o		< 0.50	< 0.50	< 0.50
Xylenes - m,p		< 0.50	< 0.50	< 0.50
Total VOCs		0	0	0
1,4-Dioxane [2,3]		**2.14**	**0.430**	**4.27**

See last page for Notes and Abbreviations.

Table 6
Concentrations of Volatile Organic Compounds
and 1,4-Dioxane in Monitoring Wells [1]
BPOW 2-1, BPOW 2-2 and BPOW 2-3, Third Quarter 2018
Operable Unit 2 (Groundwater),
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Notes and Abbreviations:

(1) These outpost wells have been recently repurposed for use as plume monitoring wells per the June 2015 Groundwater Monitoring Plan Addendum (ARCADIS of New York, Inc., 2015) as conditionally approved by the NYSDEC (August 25, 2015). Therefore, TVOC trigger levels that may have been previously established are no longer shown

(2) Samples were analyzed for VOCs using USEPA Method 524.2; samples were analyzed for 1,4-Dioxane using USEPA Method 522

(3) Results for the program are validated at 20% frequency, per protocols specified in the OU2 Groundwater Monitoring Plan (Arcadis 2016)

4.27 Bold value indicates a detection

VOC Volatile Organic Compound

µg/L micrograms per liter

<0.5 Compound not detected above its laboratory quantification limit

FIGURES

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\Users\alsanchez\OneDrive - ARCADIS\BIM 360 Docs\NORTHROP GRUMMAN\OU2 ONCT OM&M PROGRAM\2018\NGC-BP-OU2-F-ONSITE GW REMEDY.dwg LAYOUT: 1 SAVED: 3/28/2018 12:13 PM ACADVER: 21.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 3/28/2018 12:22
PM BY: SANCHEZ, ADRIAN
XREFS: IMAGES: PROJECTNAME: ----
XrBDR-CP
XrLI-NY_RD&ST
Xr1496X01

FORMER RUCO POLYMER SITE

OU-3 GROUNDWATER/SOIL GAS TREATMENT SYSTEMS

NWIRP SITE (FORMER NAVY SITE)

OU3 OUTFALL 001

BETHPAGE COMMUNITY PARK

BETHPAGE HIGH SCHOOL

OU2 MAIN FACILITY REMEDIAL SYSTEM (TOWER 96)

OU2 MAIN FACILITY REMEDIAL SYSTEM (TOWER 102)

EXISTING OU2 TREATMENT SYSTEMS

WEST RECHARGE BASINS

OU-2 ON-SITE GROUNDWATER REMEDY TREATMENT SYSTEMS

SOUTH RECHARGE BASINS

OU2 OUTFALL 006

OU2 OUTFALL 005

HAYPATH ROAD

FARMERS AVENUE

(PLAINVIEW ROAD)

GRUMMAN ROAD

BROADWAY

CENTRAL AVENUE

LONG ISLAND RAILROAD

BLOOMINGDALE ROAD

NORTH WANTAGH AVE.

MALLARD ROAD

(GARDINER'S AVENUE)

LOWLAND ROAD

HICKSVILLE ROAD

STEWART AVENUE

SEAFORD - OYSTER BAY EXPRESSWAY

BETHPAGE STATE PARKWAY

PIKE

BOUNDARY AVENUE

HWD 10208
HWD 8779
BWD 8768
BWD 8767
BWD 9591
RW-1
RW-2
RW-3
RW-4
HN-24I
HN-24S
FW-03
HN-42S
HN-42I
HN-40S
HN-40I
GM-13D
GM-16I
GM-16SR
MW-3-1
WELL 3R
10597
WELL 3
GM-17SR
GM-17I
GM-17D
MW-1GF
GM-32S
WELL 1
GM-39DA
GM-39DB
MW-2GF
GM-18S
GM-18I
GM-18D
GM-33D2
10631
WELL-17
10600
GM-78S
GM-78I
GM-78D
GM-78D2
9921
GM-75D2
10624
10627
GM-20I
GM-20D
GM-21S
GM-21I
GM-21D
GM-21D2
10633
GM-49S
GM-19D
MW-5
MW-4
MW-6
GM-15SR
GM-15I
GM-15D
GM-15D2
GM-73D3
GM-73D2
GM-73D
WELL-18
GM-74I
GM-74D
GM-74D2
GM-74D3
WELL-19
GM-79I
GM-79D
10628
GM-37D
GM-37D2
GM-71D2
GM-70D2
10634
GM-35D2
GM-36D
GM-36D2
N-10821
BWD 6915
BWD 6916
BWD 8941
3876
GM-34D
GM-34D2
GM-38D
GM-38D2
BWD 8004
TOH(LWD) 7076
BPOW 1-4
BPOW 1-5
BPOW 1-6
BPOW 1-3
BPOW 1-1
BPOW 1-2
SFWD 7377
SFWD 5148
SFWD 4043
BPOW 4-2R
BPOW 4-1R
TOH(LWD) 5303
BPOW 2-2
BPOW 2-3
BPOW 2-1
SFWD 6150
BPOW 3-3
BPOW 3-4
BPOW 3-2
BPOW 3-1
NYAW 9338
NYAW 8480

EXPLANATION

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE SITE
- PROPERTY BOUNDARY OF THE FORMER NAVY SITE
- PROPERTY BOUNDARY OF THE FORMER OXY/RUCO SITE
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY (AS OF 2009)
- DENOTES NAVY OWNED PROPERTY (AS OF 2014)
- RECHARGE BASIN
- 10592 OBSERVATION/MONITORING/OUTPOST WELL (1)
- 9591 PUBLIC SUPPLY WELL (2)
- WELL-17 NORTHROP GRUMMAN REMEDIAL WELL
- PART OF ON-SITE REMEDY
- NWIRP NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
- TOH (LWD) TOWN OF HEMPSTEAD LEVITOWN WATER DISTRICT
- HWD HICKSVILLE WATER DISTRICT
- SFWD SOUTH FARMINGDALE WATER DISTRICT
- BWD BETHPAGE WATER DISTRICT
- NYAW NEW YORK AMERICAN WATER

NOTE:

(1) THIS FIGURE DEPICTS OBSERVATION/MONITORING/OUTPOST WELLS INCLUDED IN THE OU-2 GROUNDWATER MONITORING PROGRAM.

(2) PUBLIC SUPPLY WELLS ARE NOT SAMPLED AS A PART OF THE OU2 GROUNDWATER MONITORING PROGRAM AND ARE ONLY FOR REFERENCE.

0 1000' 2000'
APPROXIMATE SCALE IN FEET

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

LOCATIONS OF WELLS AND ON-SITE GROUNDWATER REMEDY

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FIGURE 1

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK
OPERABLE UNIT 2

ONCT GROUNDWATER EXTRACTION AND TREATMENT SYSTEM SITE PLAN

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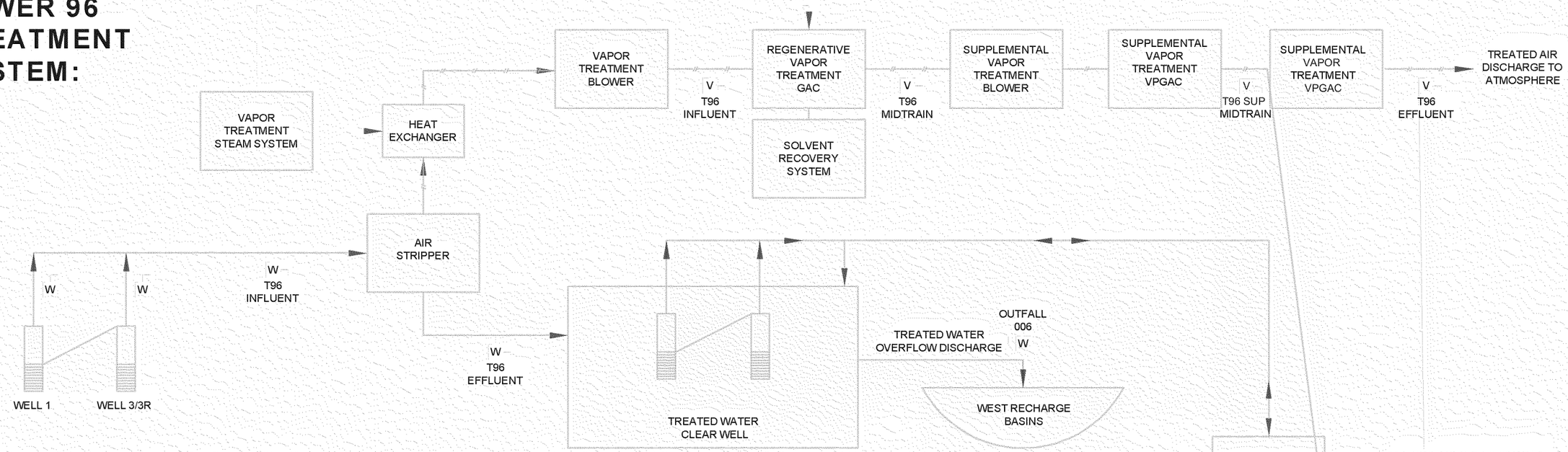
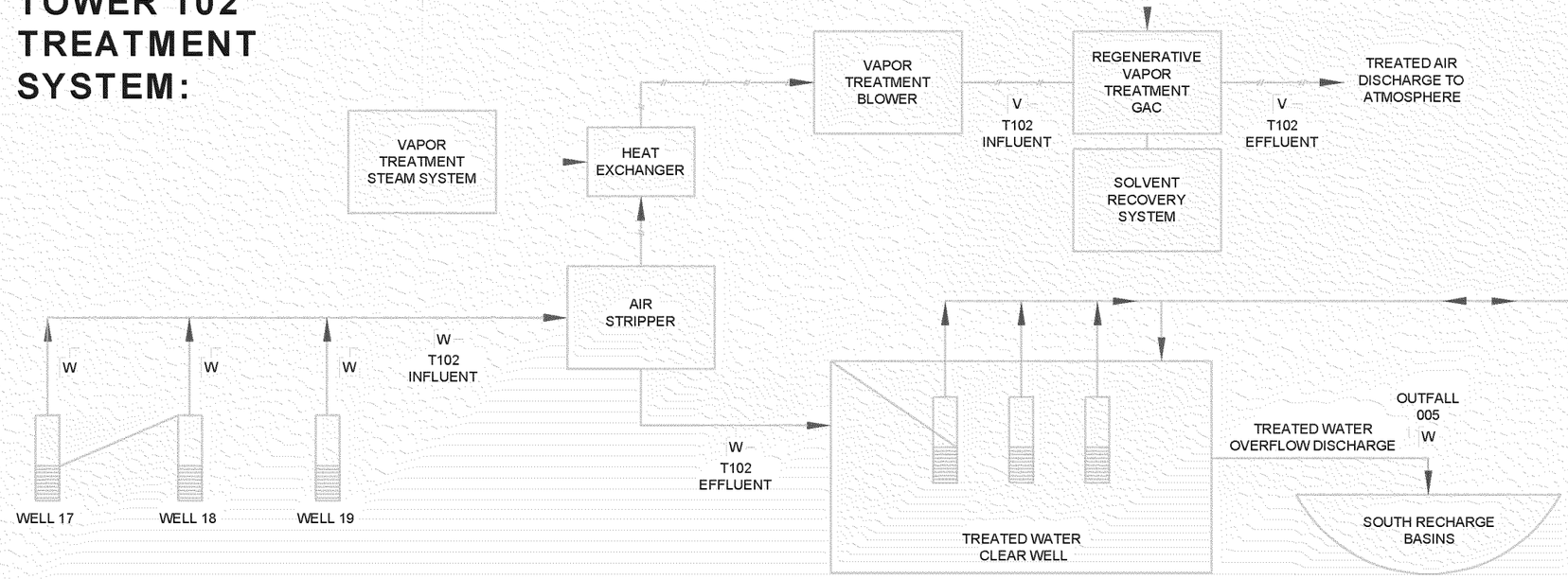
FIGURE
2

TOWER 96 TREATMENT SYSTEM:



TOWER 102 TREATMENT SYSTEM:



LEGEND:

- PROCESS WATER
- PROCESS AIR
- STEAM
- SAMPLE LOCATION
- W — WATER SAMPLE
- V — VAPOR SAMPLE
- ONCT — ON-SITE CONTAMINANT

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK
OPERABLE UNIT 2

ONCT GROUNDWATER EXTRACTION AND TREATMENT SYSTEM SCHEMATIC

ARCADIS Design & Consultancy for natural and built assets

FIGURE **3**